1 VAR Revision

Consider the three variables: PCR - Private Consumption; GCR - Government Consumption; and URX - Unemployment Rate and define $\boldsymbol{Y}_t = (l_P CR_t, l_G CR_t, URX_t)'$.

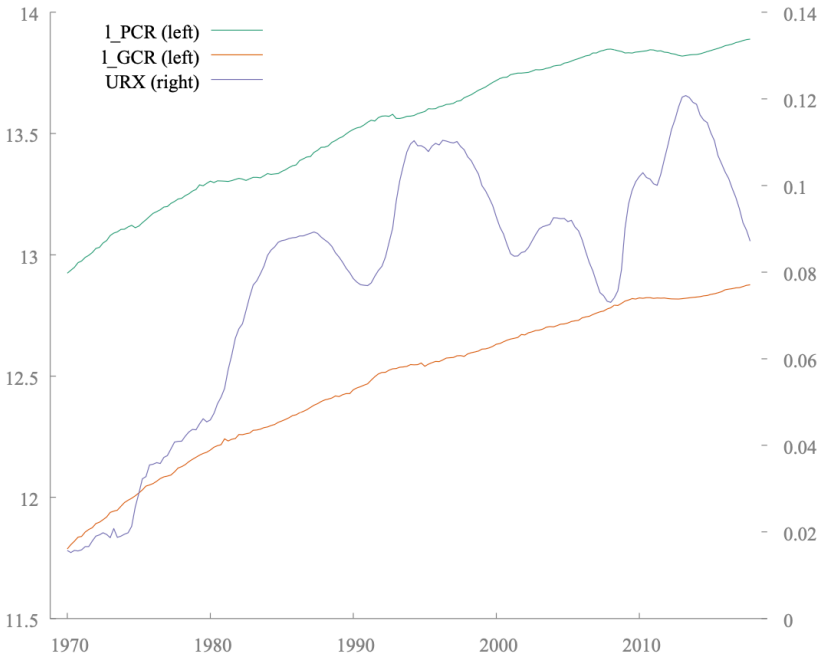

Figure 1

Series are trending, hence nonstationary, but it is important to know whether the nonstationarity is due to a unit root or not. Thus, we apply unit root tests to all three series.

1.1 Unit Root Testing

```
Augmented Dickey-Fuller test for l_PCR
testing down from 14 lags, criterion AIC
sample size 187
unit-root null hypothesis: a = 1

  test with constant
  including 4 lags of (1-L)l_PCR
  model: (1-L)y = b0 + (a-1)*y(-1) + ... + e
  estimated value of (a - 1): -0.00372724
  test statistic: tau_c(1) = -2.34514
  asymptotic p-value 0.1578
  1st-order autocorrelation coeff. for e: -0.006
  lagged differences: F(4, 181) = 7.178 [0.0000]

  with constant and trend
  including 4 lags of (1-L)l_PCR
  model: (1-L)y = b0 + b1*t + (a-1)*y(-1) + ... + e
  estimated value of (a - 1): -0.0106643
  test statistic: tau_ct(1) = -1.61859
  asymptotic p-value 0.786
  1st-order autocorrelation coeff. for e: -0.008
  lagged differences: F(4, 180) = 7.463 [0.0000]
```

Figure 2: ADF for l_PCR

```
Augmented Dickey-Fuller test for l_GCR
testing down from 14 lags, criterion AIC
sample size 187
unit-root null hypothesis: a = 1

  test with constant
  including 4 lags of (1-L)l_GCR
  model: (1-L)y = b0 + (a-1)*y(-1) + ... + e
  estimated value of (a - 1): -0.00609162
  test statistic: tau_c(1) = -3.71919
  asymptotic p-value 0.003872
  1st-order autocorrelation coeff. for e: -0.022
  lagged differences: F(4, 181) = 5.757 [0.0002]

  with constant and trend
  including 4 lags of (1-L)l_GCR
  model: (1-L)y = b0 + b1*t + (a-1)*y(-1) + ... + e
  estimated value of (a - 1): -0.01292
  test statistic: tau_ct(1) = -2.25415
  asymptotic p-value 0.4587
  1st-order autocorrelation coeff. for e: -0.023
  lagged differences: F(4, 180) = 5.643 [0.0003]
```

Figure 3: ADF for l_GCR

```
Augmented Dickey-Fuller test for URX
testing down from 14 lags, criterion AIC
sample size 190
unit-root null hypothesis: a = 1

  test with constant
  including one lag of (1-L)URX
  model: (1-L)y = b0 + (a-1)*y(-1) + ... + e
  estimated value of (a - 1): -0.00685106
  test statistic: tau_c(1) = -2.39467
  asymptotic p-value 0.1432
  1st-order autocorrelation coeff. for e: -0.100

  with constant and trend
  including one lag of (1-L)URX
  model: (1-L)y = b0 + b1*t + (a-1)*y(-1) + ... + e
  estimated value of (a - 1): -0.00949524
  test statistic: tau_ct(1) = -1.93244
  asymptotic p-value 0.6373
  1st-order autocorrelation coeff. for e: -0.108
```

Figure 4: ADF for URX

1.2 SVAR estimation

Consider the following SVAR model:

$$\Gamma_0 \boldsymbol{Y}_t = \boldsymbol{\mu} + \sum_{i=1}^{p} \Gamma_i \boldsymbol{Y}_{t-i} + \boldsymbol{\varepsilon}_t \tag{1}$$

For estimation we use the reduced form of the SVAR, i.e.:

$$\begin{aligned}
\Gamma_0 \boldsymbol{Y}_t &= \boldsymbol{\mu} + \sum_{i=1}^{p} \Gamma_i \boldsymbol{Y}_{t-i} + \boldsymbol{\varepsilon}_t \\
\boldsymbol{Y}_t &= \Gamma_0^{-1}\boldsymbol{\mu} + \sum_{i=1}^{p} \Gamma_0^{-1}\Gamma_i \boldsymbol{Y}_{t-i} + \Gamma_0^{-1}\boldsymbol{\varepsilon}_t \\
\boldsymbol{Y}_t &= A_0 + \sum_{i=1}^{p} A_i \boldsymbol{Y}_{t-i} + B\boldsymbol{\varepsilon}_t \\
\boldsymbol{Y}_t &= A_0 + \sum_{i=1}^{p} A_i \boldsymbol{Y}_{t-i} + \mathbf{u}_t
\end{aligned} \tag{2}$$

where $A_0 = \Gamma_0^{-1}\boldsymbol{\mu}$, $A_i = \Gamma_0^{-1}\Gamma_i$, $i = 1, ..., p$, and $B = \Gamma_0^{-1}$.

Hence, for identification of the SVAR we need to estimate reduced form VAR in (2). Estimation can be done by MLE or equation by equation using OLS. Given the nonstationarity of the data we are going to start with the estimation of a VAR in first differences.

1.2.1 Order identification

VAR system, maximum lag order 8. - FIRST DIFFERENCES

The asterisks below indicate the best (that is, minimized) values
of the respective information criteria, AIC = Akaike criterion,
BIC = Schwarz Bayesian criterion and HQC = Hannan-Quinn criterion.

lags	loglik	p(LR)	AIC	BIC	HQC
1	2430.47176		-26.431385	-26.220927*	-26.346076
2	2451.21621	0.00000	-26.559740	-26.191438	-26.410449
3	2467.24463	0.00019	-26.636553	-26.110408	-26.423281
4	2488.75468	0.00000	-26.773275	-26.089286	-26.496021*
5	2499.78354	0.00870	-26.795449*	-25.953616	-26.454212
6	2503.93303	0.50432	-26.742438	-25.742762	-26.337220
7	2505.76632	0.93196	-26.664113	-25.506593	-26.194913
8	2513.97846	0.05853	-26.655502	-25.340139	-26.122321

Figure 5

Considering the three Information Criteria AIC, BIC and HQC, we see that each points to a different order of the VAR(p). AIC suggests a VAR(5), BIC suggest a VAR(1) and HQC suggests a VAR(4).

1.2.2 VAR Estimation

VAR(1)

VAR system, lag order 1
OLS estimates, observations 1970:3-2017:4 (T = 190)
Log-likelihood = 2518.2801
Determinant of covariance matrix = 6.1688895e-16
AIC = -26.3819
BIC = -26.1768
HQC = -26.2988
Portmanteau test: LB(47) = 519.494, df = 414 [0.0003]

Equation 1: d_l_PCR
Heteroskedasticity-robust standard errors, variant HC3

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	0.00342661	0.000573935	5.970	<0.0001	***
d_l_PCR_1	0.168015	0.0856345	1.962	0.0513	*
d_l_GCR_1	0.168872	0.0975532	1.731	0.0851	*
d_URX_1	−0.596043	0.209372	−2.847	0.0049	***

Mean dependent var	0.005012	S.D. dependent var	0.005565
Sum squared resid	0.005071	S.E. of regression	0.005221
R-squared	0.133719	Adjusted R-squared	0.119747
F(3, 186)	12.65541	P-value(F)	1.45e-07
rho	−0.085304	Durbin-Watson	2.165098

F-tests of zero restrictions:
All lags of d_l_PCR F(1, 186) = 3.8494 [0.0513]
All lags of d_l_GCR F(1, 186) = 2.9966 [0.0851]
All lags of d_URX F(1, 186) = 8.1043 [0.0049]
All vars, lag 1 F(3, 186) = 12.655 [0.0000]

Figure 6

Equation 2: d_l_GCR
Heteroskedasticity-robust standard errors, variant HC3

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	0.00378492	0.000541995	6.983	<0.0001	***
d_l_PCR_1	0.298846	0.0803622	3.719	0.0003	***
d_l_GCR_1	0.0345613	0.104630	0.3303	0.7415	
d_URX_1	0.377100	0.161566	2.334	0.0207	**

Mean dependent var	0.005644	S.D. dependent var	0.004974
Sum squared resid	0.004161	S.E. of regression	0.004730
R-squared	0.110144	Adjusted R-squared	0.095791
F(3, 186)	8.127342	P-value(F)	0.000041
rho	−0.105421	Durbin-Watson	2.199715

F-tests of zero restrictions:

All lags of d_l_PCR	F(1, 186) = 13.829 [0.0003]
All lags of d_l_GCR	F(1, 186) = 0.10911 [0.7415]
All lags of d_URX	F(1, 186) = 5.4477 [0.0207]
All vars, lag 1	F(3, 186) = 8.1273 [0.0000]

Figure 7

Equation 3: d_URX
Heteroskedasticity-robust standard errors, variant HC3

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	3.23554e-05	0.000141970	0.2279	0.8200	
d_l_PCR_1	−0.0362565	0.0187080	−1.938	0.0541	*
d_l_GCR_1	0.0403979	0.0181995	2.220	0.0276	**
d_URX_1	0.767855	0.0639828	12.00	<0.0001	***

Mean dependent var	0.000379	S.D. dependent var	0.001931
Sum squared resid	0.000241	S.E. of regression	0.001138
R-squared	0.658530	Adjusted R-squared	0.653022
F(3, 186)	53.58349	P-value(F)	5.22e-25
rho	−0.119410	Durbin-Watson	2.229797

F-tests of zero restrictions:

All lags of d_l_PCR	F(1, 186) = 3.7559 [0.0541]
All lags of d_l_GCR	F(1, 186) = 4.9272 [0.0276]
All lags of d_URX	F(1, 186) = 144.02 [0.0000]
All vars, lag 1	F(3, 186) = 53.583 [0.0000]

Figure 8

Test for autocorrelation of order up to 4

	Rao F	Approx dist.	p-value
lag 1	5.435	F(9, 440)	0.0000
lag 2	3.932	F(18, 503)	0.0000
lag 3	3.677	F(27, 511)	0.0000
lag 4	3.517	F(36, 508)	0.0000

Figure 9

Test for ARCH of order up to 4

	LM	df	p-value
lag 1	84.274	36	0.0000
lag 2	121.762	72	0.0002
lag 3	171.126	108	0.0001
lag 4	214.000	144	0.0001

Figure 10

VAR(4)

VAR system, lag order 4
OLS estimates, observations 1971:2-2017:4 (T = 187)
Log-likelihood = 2542.0388
Determinant of covariance matrix = 3.127236e-16
AIC = -26.7705
BIC = -26.0966
HQC = -26.4974
Portmanteau test: LB(46) = 391.292, df = 378 [0.3078]

Equation 1: d_l_PCR
Heteroskedasticity-robust standard errors, variant HC3

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	0.000749869	0.000631040	1.188	0.2363	
d_l_PCR_1	−0.00428587	0.0931728	−0.04600	0.9634	
d_l_PCR_2	0.161027	0.0805779	1.998	0.0472	**
d_l_PCR_3	0.159473	0.105859	1.506	0.1338	
d_l_PCR_4	0.175406	0.0944164	1.858	0.0649	*
d_l_GCR_1	−0.0151193	0.0876023	−0.1726	0.8632	
d_l_GCR_2	0.126740	0.0809851	1.565	0.1194	
d_l_GCR_3	0.108946	0.0994260	1.096	0.2747	
d_l_GCR_4	0.0781078	0.0964088	0.8102	0.4189	
d_URX_1	−0.978974	0.370183	−2.645	0.0089	***
d_URX_2	0.718968	0.434678	1.654	0.0999	*
d_URX_3	−0.324072	0.381310	−0.8499	0.3966	
d_URX_4	0.459169	0.270849	1.695	0.0918	*

Mean dependent var	0.004889	S.D. dependent var	0.005486
Sum squared resid	0.003850	S.E. of regression	0.004704
R-squared	0.312065	Adjusted R-squared	0.264622
F(12, 174)	6.725895	P-value(F)	7.13e-10
rho	−0.025594	Durbin-Watson	2.048922

F-tests of zero restrictions:

All lags of d_l_PCR	F(4, 174) = 2.9405 [0.0220]
All lags of d_l_GCR	F(4, 174) = 0.88121 [0.4764]
All lags of d_URX	F(4, 174) = 2.46 [0.0472]
All vars, lag 4	F(3, 174) = 2.2197 [0.0876]

Figure 11

Equation 2: d_l_GCR
Heteroskedasticity-robust standard errors, variant HC3

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	0.00141752	0.000594055	2.386	0.0181	**
d_l_PCR_1	0.134657	0.0788851	1.707	0.0896	*
d_l_PCR_2	0.131622	0.0804896	1.635	0.1038	
d_l_PCR_3	0.0539787	0.0904664	0.5967	0.5515	
d_l_PCR_4	0.139304	0.0817755	1.703	0.0903	*
d_l_GCR_1	−0.188359	0.102392	−1.840	0.0675	*
d_l_GCR_2	0.0277204	0.0689274	0.4022	0.6881	
d_l_GCR_3	0.189429	0.0922384	2.054	0.0415	**
d_l_GCR_4	0.273713	0.0885348	3.092	0.0023	***
d_URX_1	0.395743	0.331347	1.194	0.2340	
d_URX_2	0.340396	0.396611	0.8583	0.3919	
d_URX_3	−0.101672	0.409616	−0.2482	0.8043	
d_URX_4	−0.403153	0.291988	−1.381	0.1691	

Mean dependent var	0.005552	S.D. dependent var	0.004907
Sum squared resid	0.002862	S.E. of regression	0.004055
R-squared	0.361086	Adjusted R-squared	0.317023
F(12, 174)	7.092947	P-value(F)	1.91e-10
rho	−0.073552	Durbin-Watson	2.143635

F-tests of zero restrictions:

All lags of d_l_PCR	F(4, 174) = 1.7654 [0.1379]
All lags of d_l_GCR	F(4, 174) = 4.451 [0.0019]
All lags of d_URX	F(4, 174) = 1.6519 [0.1634]
All vars, lag 4	F(3, 174) = 5.6828 [0.0010]

Figure 12

Equation 3: d_URX
Heteroskedasticity-robust standard errors, variant HC3

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	−9.57098e-05	0.000202393	−0.4729	0.6369	
d_l_PCR_1	−0.0552403	0.0218004	−2.534	0.0122	**
d_l_PCR_2	−0.0530721	0.0194635	−2.727	0.0071	***
d_l_PCR_3	−0.0122085	0.0212036	−0.5758	0.5655	
d_l_PCR_4	−0.0128539	0.0201750	−0.6371	0.5249	
d_l_GCR_1	0.0359075	0.0206060	1.743	0.0832	*
d_l_GCR_2	0.0111331	0.0235886	0.4720	0.6375	
d_l_GCR_3	0.0644515	0.0226136	2.850	0.0049	***
d_l_GCR_4	0.0453393	0.0191269	2.370	0.0189	**
d_URX_1	0.586874	0.124945	4.697	<0.0001	***
d_URX_2	0.106125	0.126641	0.8380	0.4032	
d_URX_3	0.0199550	0.0996021	0.2003	0.8414	
d_URX_4	−0.0729299	0.0794322	−0.9181	0.3598	

Mean dependent var	0.000381	S.D. dependent var	0.001946
Sum squared resid	0.000209	S.E. of regression	0.001096
R-squared	0.703359	Adjusted R-squared	0.682901
F(12, 174)	21.10824	P-value(F)	4.24e-28
rho	−0.001656	Durbin-Watson	1.998503

F-tests of zero restrictions:

All lags of d_l_PCR	F(4, 174) = 2.9716 [0.0209]
All lags of d_l_GCR	F(4, 174) = 3.0702 [0.0178]
All lags of d_URX	F(4, 174) = 21.581 [0.0000]
All vars, lag 4	F(3, 174) = 2.2982 [0.0792]

Figure 13

Test for autocorrelation of order up to 4

	Rao F	Approx dist.	p-value
lag 1	1.696	F(9, 411)	0.0878
lag 2	1.695	F(18, 470)	0.0369
lag 3	1.269	F(27, 476)	0.1675
lag 4	1.189	F(36, 473)	0.2131

Figure 14

Test for ARCH of order up to 4

	LM	df	p-value
lag 1	57.322	36	0.0134
lag 2	99.287	72	0.0183
lag 3	153.813	108	0.0025
lag 4	182.671	144	0.0162

Figure 15

VAR(5)

VAR system, lag order 5
OLS estimates, observations 1971:3-2017:4 (T = 186)
Log-likelihood = 2539.9795
Determinant of covariance matrix = 2.762463e-16
AIC = -26.7955
BIC = -25.9630
HQC = -26.4581
Portmanteau test: LB(46) = 351.533, df = 369 [0.7353]

Equation 1: d_l_PCR
Heteroskedasticity-robust standard errors, variant HC3

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	0.000609325	0.000617503	0.9868	0.3252	
d_l_PCR_1	−0.0302942	0.0909907	−0.3329	0.7396	
d_l_PCR_2	0.127794	0.0876001	1.459	0.1465	
d_l_PCR_3	0.129307	0.102684	1.259	0.2097	
d_l_PCR_4	0.180358	0.102521	1.759	0.0803	*
d_l_PCR_5	0.109458	0.111088	0.9853	0.3259	
d_l_GCR_1	−0.0430026	0.100330	−0.4286	0.6687	
d_l_GCR_2	0.107039	0.0920602	1.163	0.2466	
d_l_GCR_3	0.0892211	0.107833	0.8274	0.4092	
d_l_GCR_4	0.0648365	0.104340	0.6214	0.5352	
d_l_GCR_5	0.0700105	0.108492	0.6453	0.5196	
d_URX_1	−1.03139	0.391770	−2.633	0.0093	***
d_URX_2	0.649859	0.443483	1.465	0.1447	
d_URX_3	−0.246966	0.416950	−0.5923	0.5544	
d_URX_4	0.337671	0.337283	1.001	0.3182	
d_URX_5	0.232930	0.294535	0.7908	0.4301	

Mean dependent var	0.004837	S.D. dependent var	0.005452
Sum squared resid	0.003771	S.E. of regression	0.004710
R-squared	0.314402	Adjusted R-squared	0.253908
F(15, 170)	5.568079	P-value(F)	3.74e-09
rho	0.002071	Durbin-Watson	1.995347

F-tests of zero restrictions:

All lags of d_l_PCR	F(5, 170) = 1.9807 [0.0839]
All lags of d_l_GCR	F(5, 170) = 0.85922 [0.5099]
All lags of d_URX	F(5, 170) = 2.1264 [0.0646]
All vars, lag 5	F(3, 170) = 0.57891 [0.6296]

Figure 16

Equation 2: d_l_GCR
Heteroskedasticity-robust standard errors, variant HC3

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	0.00146263	0.000583397	2.507	0.0131	**
d_l_PCR_1	0.126431	0.0769442	1.643	0.1022	
d_l_PCR_2	0.0906528	0.0811436	1.117	0.2655	
d_l_PCR_3	0.0505655	0.0885496	0.5710	0.5687	
d_l_PCR_4	0.157490	0.0776870	2.027	0.0442	**
d_l_PCR_5	0.0957589	0.0721330	1.328	0.1861	
d_l_GCR_1	−0.259917	0.107051	−2.428	0.0162	**
d_l_GCR_2	−0.0252587	0.0688711	−0.3668	0.7143	
d_l_GCR_3	0.136981	0.0895397	1.530	0.1279	
d_l_GCR_4	0.267793	0.0885860	3.023	0.0029	***
d_l_GCR_5	0.118213	0.0663950	1.780	0.0768	*
d_URX_1	0.278029	0.322358	0.8625	0.3896	
d_URX_2	0.291292	0.368492	0.7905	0.4303	
d_URX_3	0.145788	0.441196	0.3304	0.7415	
d_URX_4	0.0375167	0.252659	0.1485	0.8821	
d_URX_5	−0.609499	0.274236	−2.223	0.0276	**

Mean dependent var	0.005486	S.D. dependent var	0.004836
Sum squared resid	0.002670	S.E. of regression	0.003963
R-squared	0.382693	Adjusted R-squared	0.328225
F(15, 170)	7.355620	P-value(F)	2.22e-12
rho	−0.002841	Durbin-Watson	2.004936

F-tests of zero restrictions:

All lags of d_l_PCR	F(5, 170) = 1.9634 [0.0865]
All lags of d_l_GCR	F(5, 170) = 3.4896 [0.0050]
All lags of d_URX	F(5, 170) = 1.7266 [0.1310]
All vars, lag 5	F(3, 170) = 3.6374 [0.0141]

Figure 17

Equation 3: d_URX
Heteroskedasticity-robust standard errors, variant HC3

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	−0.000103820	0.000200676	−0.5173	0.6056	
d_l_PCR_1	−0.0604833	0.0218494	−2.768	0.0063	***
d_l_PCR_2	−0.0603998	0.0213631	−2.827	0.0053	***
d_l_PCR_3	−0.0142538	0.0213586	−0.6674	0.5054	
d_l_PCR_4	−0.00652039	0.0213332	−0.3056	0.7602	
d_l_PCR_5	0.0436833	0.0194890	2.241	0.0263	**
d_l_GCR_1	0.0253896	0.0203335	1.249	0.2135	
d_l_GCR_2	0.00433294	0.0260057	0.1666	0.8679	
d_l_GCR_3	0.0540348	0.0232382	2.325	0.0212	**
d_l_GCR_4	0.0368622	0.0208338	1.769	0.0786	*
d_l_GCR_5	0.00201828	0.0225276	0.08959	0.9287	
d_URX_1	0.579356	0.120281	4.817	<0.0001	***
d_URX_2	0.0983097	0.121807	0.8071	0.4207	
d_URX_3	0.0618373	0.108143	0.5718	0.5682	
d_URX_4	−0.0264177	0.0917960	−0.2878	0.7739	
d_URX_5	−0.0354625	0.0751701	−0.4718	0.6377	

Mean dependent var	0.000379	S.D. dependent var	0.001951
Sum squared resid	0.000202	S.E. of regression	0.001089
R-squared	0.713824	Adjusted R-squared	0.688574
F(15, 170)	17.64912	P-value(F)	2.24e-27
rho	−0.017577	Durbin-Watson	2.024990

F-tests of zero restrictions:

All lags of d_l_PCR	F(5, 170) = 3.428 [0.0056]
All lags of d_l_GCR	F(5, 170) = 1.4179 [0.2202]
All lags of d_URX	F(5, 170) = 16.371 [0.0000]
All vars, lag 5	F(3, 170) = 2.14 [0.0970]

Figure 18

For the system as a whole
Null hypothesis: the longest lag is 4
Alternative hypothesis: the longest lag is 5
Likelihood ratio test: Chi-square(9) = 24.8835 [0.0031]

```
Test for autocorrelation of order up to 4

          Rao F   Approx dist.  p-value
lag 1     0.627     F(9, 401)     0.7742
lag 2     0.659     F(18, 458)    0.8518
lag 3     0.890     F(27, 465)    0.6273
lag 4     1.089     F(36, 461)    0.3370


Residual correlation matrix, C (3 x 3)

      1.0000      0.12535     -0.33110
     0.12535       1.0000    -0.015104
    -0.33110    -0.015104       1.0000

Eigenvalues of C

   0.650741
   0.990008
    1.35925

Doornik-Hansen test
 Chi-square(6) = 7.1822 [1.0000]


Test for ARCH of order up to 4

           LM       df      p-value
lag 1    49.853     36       0.0622
lag 2    91.782     72       0.0579
lag 3   154.157    108       0.0024
lag 4   180.922    144       0.0201
```

Figure 19

1.3 IRFs

Short-run restrictions used for identification

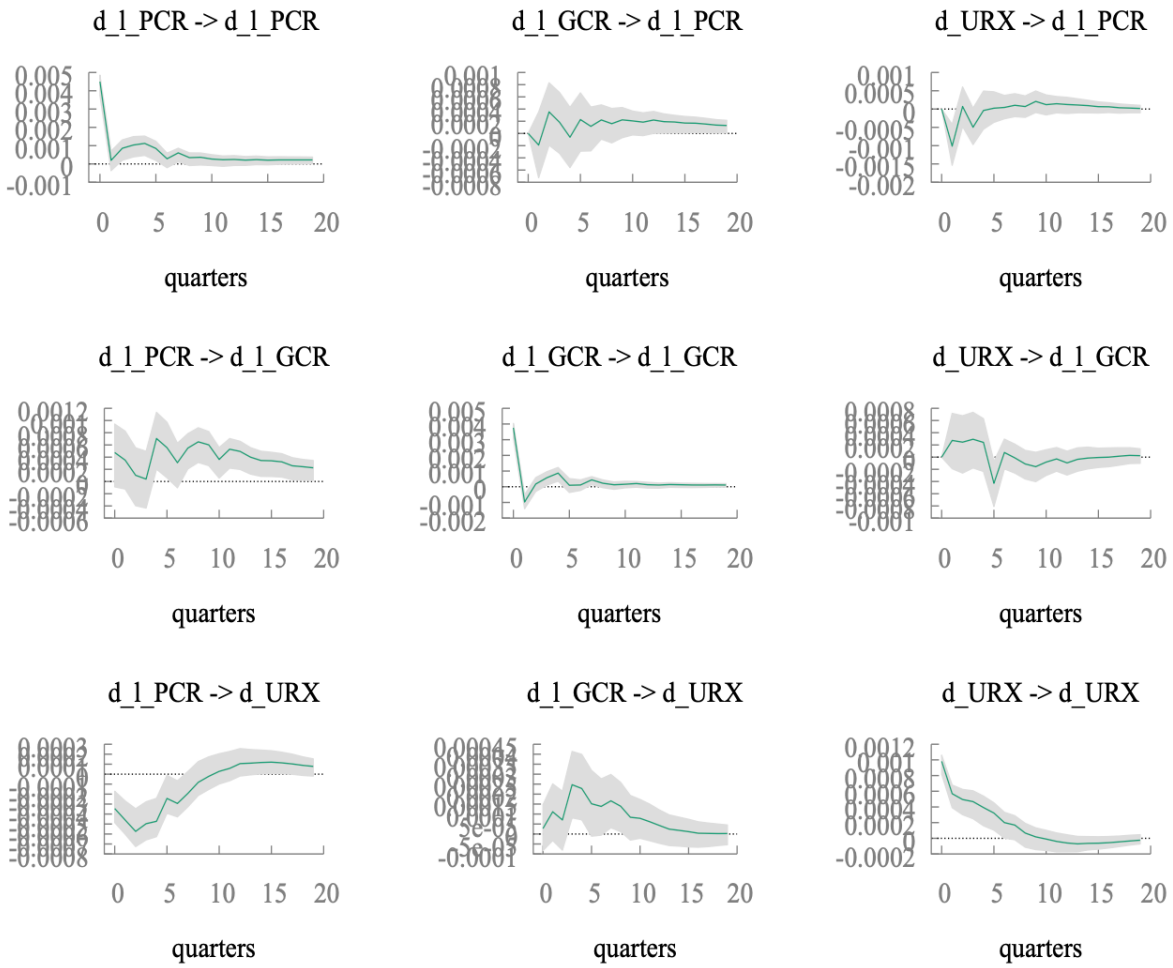

Figure 20

1.4 Forecast Variance Decomposition

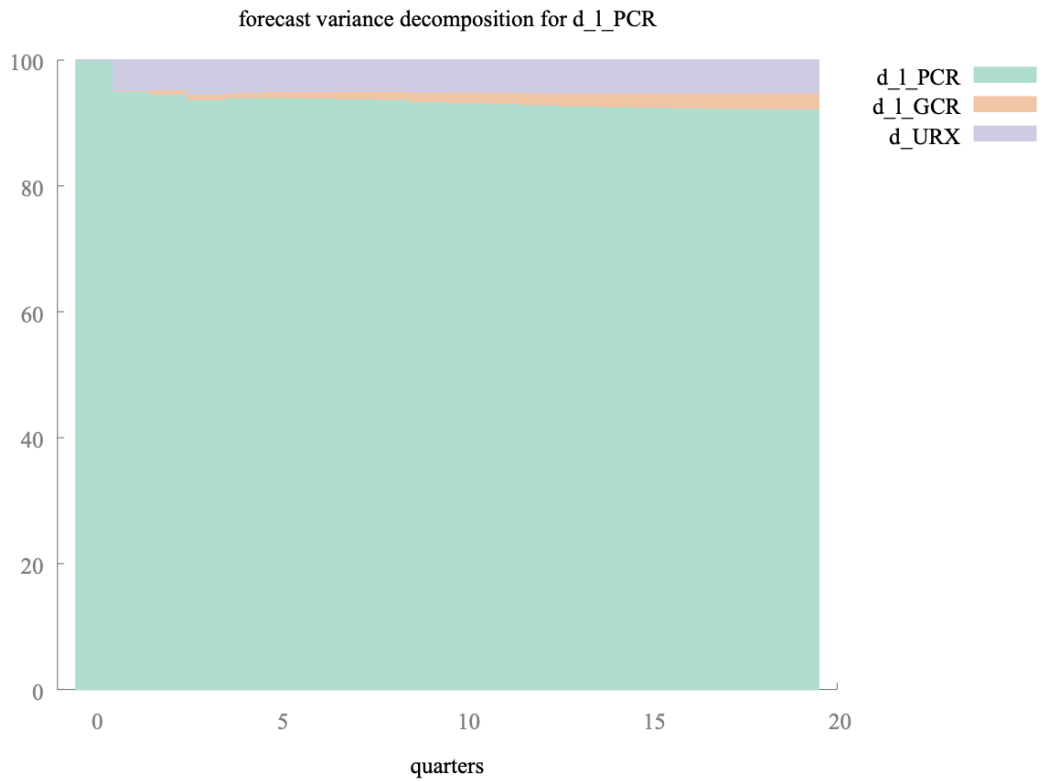

Figure 21

2 Analysis in Levels

2.1 Johansen Test

```
Johansen test:
Number of equations = 3
Lag order = 2
Estimation period: 1970:3 - 2017:4 (T = 190)
Case 3: Unrestricted constant

Log-likelihood = 3113.75 (including constant term: 2574.56)

Rank Eigenvalue Trace test  p-value  Lmax test  p-value
   0    0.38829     112.55 [0.0000]     93.384 [0.0000]
   1   0.086186     19.167 [0.0120]     17.124 [0.0153]
   2   0.010694     2.0427 [0.1529]     2.0427 [0.1529]

Corrected for sample size (df = 183)
Rank Trace test p-value
   0     112.55 [0.0000]
   1     19.167 [0.0125]
   2     2.0427 [0.1556]

eigenvalue     0.38829     0.086186     0.010694

beta (cointegrating vectors)
l_PCR           5.3570      -6.5243       55.936
l_GCR          -8.2943     -0.24743      -56.577
URX            -11.260       62.667       75.100

alpha (adjustment vectors)
l_PCR        0.0022307    0.0010626   9.0883e-05
l_GCR        0.0024042  -0.00062420   0.00016335
URX         0.00017414  -0.00012074  -0.00010442

renormalized beta
l_PCR           1.0000       26.369      0.74483
l_GCR          -1.5483       1.0000     -0.75336
URX            -2.1020      -253.28       1.0000

renormalized alpha
l_PCR         0.011950  -0.00026291    0.0068253
l_GCR         0.012879   0.00015444     0.012268
URX         0.00093288   2.9875e-05   -0.0078417

long-run matrix (alpha * beta')
                l_PCR        l_GCR          URX
l_PCR         0.010101    -0.023906     0.048297
l_GCR         0.026089    -0.029028    -0.053921
URX         -0.0041200    0.0044931    -0.017369
```

Figure 22

2.2 VECM

VECM system, lag order 5
Maximum likelihood estimates, observations 1971:2-2017:4 (T = 187)
Cointegration rank = 2
Case 3: Unrestricted constant
beta (cointegrating vectors, standard errors in parentheses)

l_PCR	1.0000	0.0000
	(0.0000)	(0.0000)
l_GCR	0.0000	1.0000
	(0.0000)	(0.0000)
URX	-15.374	-8.7439
	(3.8044)	(2.3238)

alpha (adjustment vectors)

l_PCR	0.0027316	-0.013316
l_GCR	0.011415	-0.015245
URX	0.0021127	-0.0030092

Log-likelihood = 2563.0306
Determinant of covariance matrix = 2.4983701e-16
AIC = -26.8987
BIC = -26.0693
HQC = -26.5627

Figure 23

Equation 1: d_l_PCR

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	0.125679	0.0361189	3.480	0.0006	***
d_l_PCR_1	−0.0928441	0.0812984	−1.142	0.2550	
d_l_PCR_2	0.0608322	0.0841267	0.7231	0.4706	
d_l_PCR_3	0.0591554	0.0857393	0.6899	0.4912	
d_l_PCR_4	0.0946777	0.0835407	1.133	0.2587	
d_l_GCR_1	−0.00186873	0.0855538	−0.02184	0.9826	
d_l_GCR_2	0.147581	0.0887763	1.662	0.0983	*
d_l_GCR_3	0.136120	0.0881999	1.543	0.1246	
d_l_GCR_4	0.105675	0.0860775	1.228	0.2212	
d_URX_1	−1.18812	0.338536	−3.510	0.0006	***
d_URX_2	0.531721	0.381086	1.395	0.1647	
d_URX_3	−0.434389	0.375009	−1.158	0.2483	
d_URX_4	0.245654	0.310672	0.7907	0.4302	
EC1	0.00273161	0.00325823	0.8384	0.4030	
EC2	−0.0133159	0.00523215	−2.545	0.0118	**

Mean dependent var	0.004889	S.D. dependent var	0.005486
Sum squared resid	0.003597	S.E. of regression	0.004573
R-squared	0.357409	Adjusted R-squared	0.305105
rho	−0.013521	Durbin-Watson	2.025727

Figure 24

Equation 2: d_l_GCR

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	0.0446296	0.0307381	1.452	0.1483	
d_l_PCR_1	0.0815759	0.0691872	1.179	0.2400	
d_l_PCR_2	0.0550923	0.0715941	0.7695	0.4426	
d_l_PCR_3	−0.0409216	0.0729665	−0.5608	0.5756	
d_l_PCR_4	0.0523274	0.0710954	0.7360	0.4627	
d_l_GCR_1	−0.283768	0.0728086	−3.897	0.0001	***
d_l_GCR_2	−0.0893289	0.0755510	−1.182	0.2387	
d_l_GCR_3	0.0678537	0.0750605	0.9040	0.3673	
d_l_GCR_4	0.182048	0.0732543	2.485	0.0139	**
d_URX_1	0.143326	0.288104	0.4975	0.6195	
d_URX_2	0.198116	0.324314	0.6109	0.5421	
d_URX_3	−0.103686	0.319143	−0.3249	0.7457	
d_URX_4	−0.483662	0.264391	−1.829	0.0691	*
EC1	0.0114147	0.00277285	4.117	<0.0001	***
EC2	−0.0152445	0.00445270	−3.424	0.0008	***

Mean dependent var	0.005552	S.D. dependent var	0.004907
Sum squared resid	0.002605	S.E. of regression	0.003892
R-squared	0.418398	Adjusted R-squared	0.371058
rho	−0.040895	Durbin-Watson	2.079184

Figure 25

Equation 3: d_URX

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	0.0101258	0.00852045	1.188	0.2363	
d_l_PCR_1	−0.0665368	0.0191783	−3.469	0.0007	***
d_l_PCR_2	−0.0688257	0.0198455	−3.468	0.0007	***
d_l_PCR_3	−0.0312793	0.0202259	−1.546	0.1238	
d_l_PCR_4	−0.0301147	0.0197073	−1.528	0.1283	
d_l_GCR_1	0.0189485	0.0201822	0.9389	0.3491	
d_l_GCR_2	−0.00958349	0.0209423	−0.4576	0.6478	
d_l_GCR_3	0.0430410	0.0208064	2.069	0.0401	**
d_l_GCR_4	0.0293337	0.0203057	1.445	0.1504	
d_URX_1	0.537268	0.0798608	6.728	<0.0001	***
d_URX_2	0.0768178	0.0898982	0.8545	0.3940	
d_URX_3	0.0174510	0.0884647	0.1973	0.8439	
d_URX_4	−0.0916004	0.0732877	−1.250	0.2130	
EC1	0.00211273	0.000768618	2.749	0.0066	***
EC2	−0.00300918	0.00123426	−2.438	0.0158	**

Mean dependent var	0.000381	S.D. dependent var	0.001946
Sum squared resid	0.000200	S.E. of regression	0.001079
R-squared	0.715936	Adjusted R-squared	0.692814
rho	0.008314	Durbin-Watson	1.979176

Cross-equation covariance matrix:

	l_PCR	l_GCR	URX
l_PCR	1.9233e-05	2.1048e-06	-1.5326e-06
l_GCR	2.1048e-06	1.3930e-05	-1.6839e-07
URX	-1.5326e-06	-1.6839e-07	1.0703e-06

determinant = 2.49837e-16

Figure 26

Test for autocorrelation of order up to 4

	Rao F	Approx dist.	p-value
lag 1	1.313	F(9, 411)	0.2276
lag 2	1.159	F(18, 470)	0.2915
lag 3	1.012	F(27, 476)	0.4495
lag 4	1.105	F(36, 473)	0.3147

Figure 27

Test for ARCH of order up to 4

	LM	df	p-value
lag 1	65.711	36	0.0018
lag 2	98.656	72	0.0203
lag 3	138.767	108	0.0246
lag 4	168.039	144	0.0833

Figure 28

2.3 IRFs

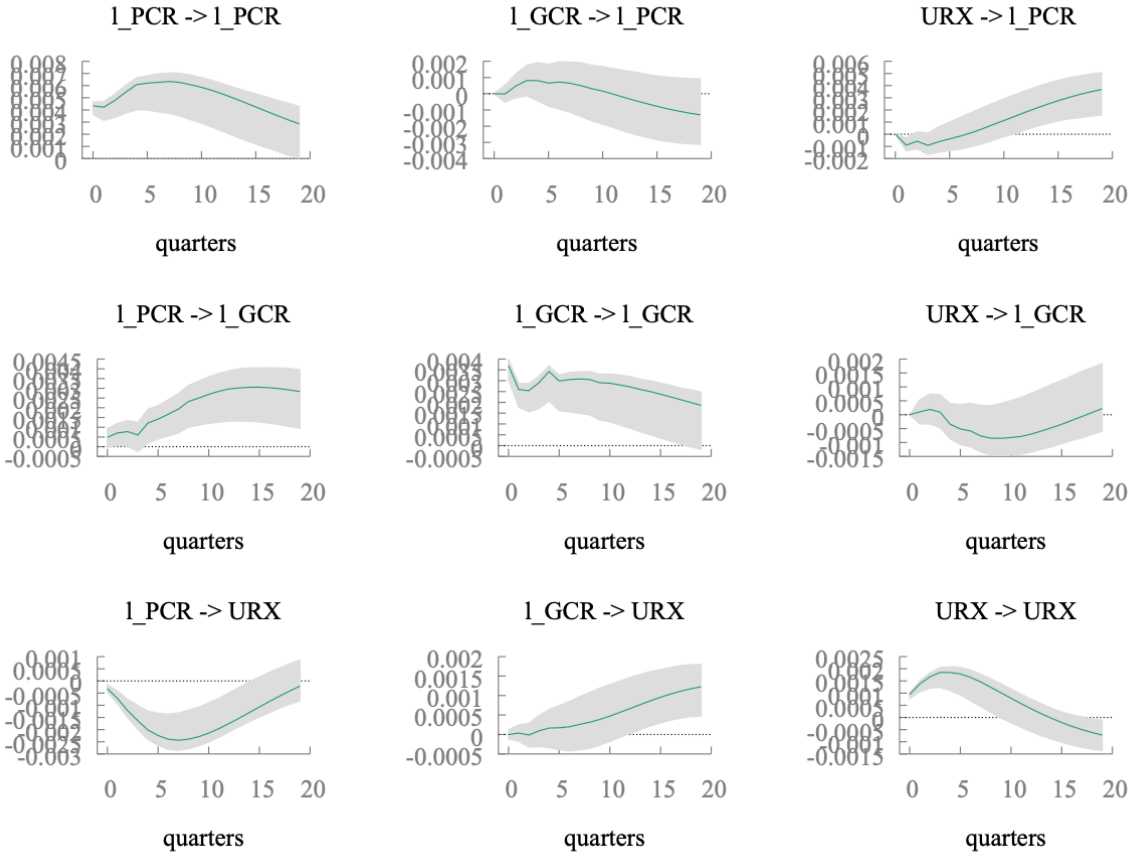

Figure 29